NEW REPORT FOR MEXICO OF *STAUROMATONEMA VIRIDE* FRÉMY, 1930 (CAPSOSIRACEAE, STIGONEMATALES)

J. CARMONA-JIMENEZ and M. GOLD-MORGAN

Laboratorio de Ficología, A.P. 70-620, C.U. Coyoacan, 04510 México City, México.

ABSTRACT - *Stauromatonema viride* Frémy, 1930 (Capsosiraceae) was observed growing at the base of *Cladophora* tufts in a small pool facing a waterfall in the state of Veracruz, Mexico. This represents the first report of this species in North America. There is some doubt in this genus regarding the basal stratum, which has been described as a prostrate multiseriate pseudoparenchymatous base by Frémy (1930), or as a cellular layer of twisted filaments by Govindu & Safeeulla (1950), although the drawing of these latter shows a layer of honeycomb-like cells. Geitler & Ruttner (1935/1936) mention coiled prostrate filaments in young stages but do not describe the basal portion in adults. In our material we have found two types of basal portions: honeycomb-like, similar to those depicted by Govindu & Safeeulla (1950), and a row of globose cells. We have ascribed our material to *Stauromatonema* because it corresponds closely to Geitler & Ruttner's emended description of this genus, and to *S. viride* because it resembles this taxon in all features except the width, which overlaps with the values of both *S. viride* and *S. nigrum* Frémy. *S. viride* has a tropical distribution and has only three previous reports, in Gabon, Sumatra and India.

RÉSUMÉ - *Stauromatonema viride* Frémy, 1930 (Capsosiraceae) a été observé au Mexique(état de Vera Cruz), en 1993, dans un petit étang de la région de El Salto de Eyipantla, en face d'une cascade. C'est la première fois que cette espèce est signalée en Amérique du nord. Il existe quelques incertitudes à propos de ce genre quant à sa strate basale décrite par Frémy (1930) comme prostrée, multisériée et pseudoparenchymateuse tandis que Govindu & Stafeeulla (1950) la signalent comme étant constituée d'un entrelacs de filaments cellulaires tordus bien que quelques-unes de leurs figures montrent une organisation de cellules en nid d'abeille. Geitler & Ruttner (1935/1936), pour leur part, mentionnent, pour les stades juvéniles, des filaments prostrés enroulés et ne donnent aucune indication sur la partie basale des adultes. Dans le cas du matériel du Mexique, deux types de structure basale sont observés. Le premier est en nid d'abeille, similaire à celui présenté par Govindu & Stafeeulla (1950); l'autre est fait de files de cellules sphériques. Notre échantillon correspond bien au genre *Stauromatonema* et à l'espèce *viride* dont tous les caractères coincident à l'exception de la largeur cellulaire qui, ici, est intermédiaire entre celle de *S. viride* et de *S. nigrum*. *S. viride* a une distribution tropicale et n'a, jusqu'à présent, été trouvé qu'au Gabon, en Inde et à Sumatra.

KEY-WORDS - *Stauromatonema viride*, Capsosiraceae, Stigonematales, Cyanoprocaryote, Cyanobacteria, Cyanophyte, freshwater, Mexican tropics.

INTRODUCTION

The cyanoprocaryote (Cyanobacteria, Cyanophyte) genus *Stauromatonema* was established by Frémy in 1930 based on material collected in Gabon (Equatorial Africa).

At that time he described two species, *Stauromatonema viride* and *Stauromatonema nigrum*. He placed this genus in the order Hormogonales and in the family Stigonemataceae. *Capsosira* Kützing is the genus morphologically most similar to *Stauromatonema*. Frémy separated both genera taking into account that the former has a convex thallus with flexuose, torulose trichomes, lateral heterocysts and hormogonia, whereas *Stauromatonema* has a flat, rigid thallus with intercalary heterocysts, lacks hormogonia and reproduces by planococci (Frémy, 1929). Bourrelly (1970) is of the opinion that these are minor differences and joins *Stauromatonema* to *Capsosira*. Anagnostidis & Komárek (1990) consider that this reclassification is possible but should be supported by field and experimental studies.

We collected *Cladophora* tufts, at the base of which were inconspicuous crustose thalli which were very similar to the descriptions and drawings by Frémy (1929) of *Stauromatonema*.

We follow the classification of Anagnostidis & Komárek (1990) in which both *Stauromatonema* and *Capsosira* are maintained and placed in the order Stigonematales, family Capsosiraceae. In 1935/1936, Geitler & Ruttner emended the description of *Stauromatonema* after studying material collected on the Sunda expedition to Indonesia, Java and Sumatra. From this material, they reported *Stauromatonema viride* and *Stauromatonema nigrum* and described a new species, *Stauromatonema minutissimum*, all from Sumatra. The only other report of this genus, of which we have knowledge, is that of Govindu & Safeeulla (1950) of *Stauromatonema viride* collected in Mysore, India.

MATERIALS AND METHODS

The sample was collected in the locality El Salto de Eyipantla, Veracruz (Fig. 1), in May 1993, in a small, shallow (1 cm) rocky pool, facing the waterfall. It is continually sprayed by the breeze from the waterfall and splash from the river. The water temperature was 25.5°C, pH 8.2 and dissolved oxygen 6.24 mg l^{-1}; the substrate was compact mud. Our material was not detected in the field, it was found under the light microscope while observing tufts of *Cladophora*; it was neither abundant nor conspicuous. The material was preserved in 4% formaldehyde and deposited in the Herbarium of the Science Faculty of the UNAM (FCME).

RESULTS

Description

Thallus an inconspicuous, irregular, olive green, crust of up to 236 µm high (Fig. 2a), formed by filaments which originate from basal cells and grow parallel to the substrate, to approximately the same height and form a compact pseudoparenchyma (Fig. 2b). Two types of basal morphology can be distinguished: globose cells (Fig. 2c) or a pseudoparenchymatose conglomerate, honeycomb-like (Fig. 3a). Filaments 5.6-11.5 µm wide. Filament cells generally quadrate, but torulose and vertically or

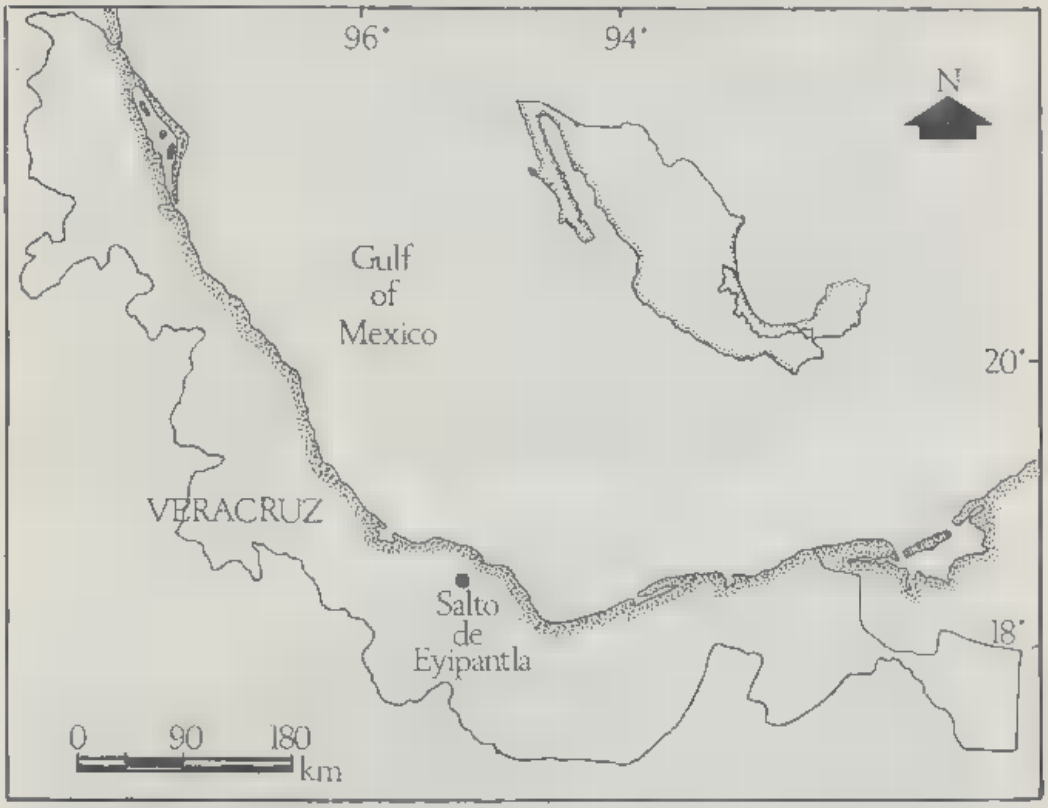

Fig. 1 - Locality «El Salto de Eyipantla», Veracruz, Mexico.

horizontally placed rectangles can also be found. Cells 3-9.5 µm wide, protoplast very granulose. True branches are present but scarce (Fig. 3b). Sheath thin and hyaline, often invisible. Heterocysts quadrate of the same size as vegetative cells, intercalary, hyaline, not easily distinguishable (Fig. 3c). Spherical or subquadrate structures were infrequently observed, apparently liberated from apical cells, 5.5-8.5 µm wide (Fig. 2b). Hormogonia lacking.

DISCUSSION

Our material undoubtedly belongs to the family Capsosiraceae (Anagnostidis & Komárek, 1990) and to the genus *Stauromatonema* (Tab. I), although we found inconsistencies in the definition of the basal stratum. In Frémy's original description the thallus is described as composed of erect filaments which grow from a prostrate multiseriate pseudoparenchymatous base (Fig. 4a, b). Geitler & Ruttner (1935/1936), in their quite detailed description of the Sumatra material, do not mention prostrate filaments in the adult stage, only coiled prostrate filaments in young stages; and Govindu & Safeeulla (1950) describe a cellular layer of twisted filaments in the basal

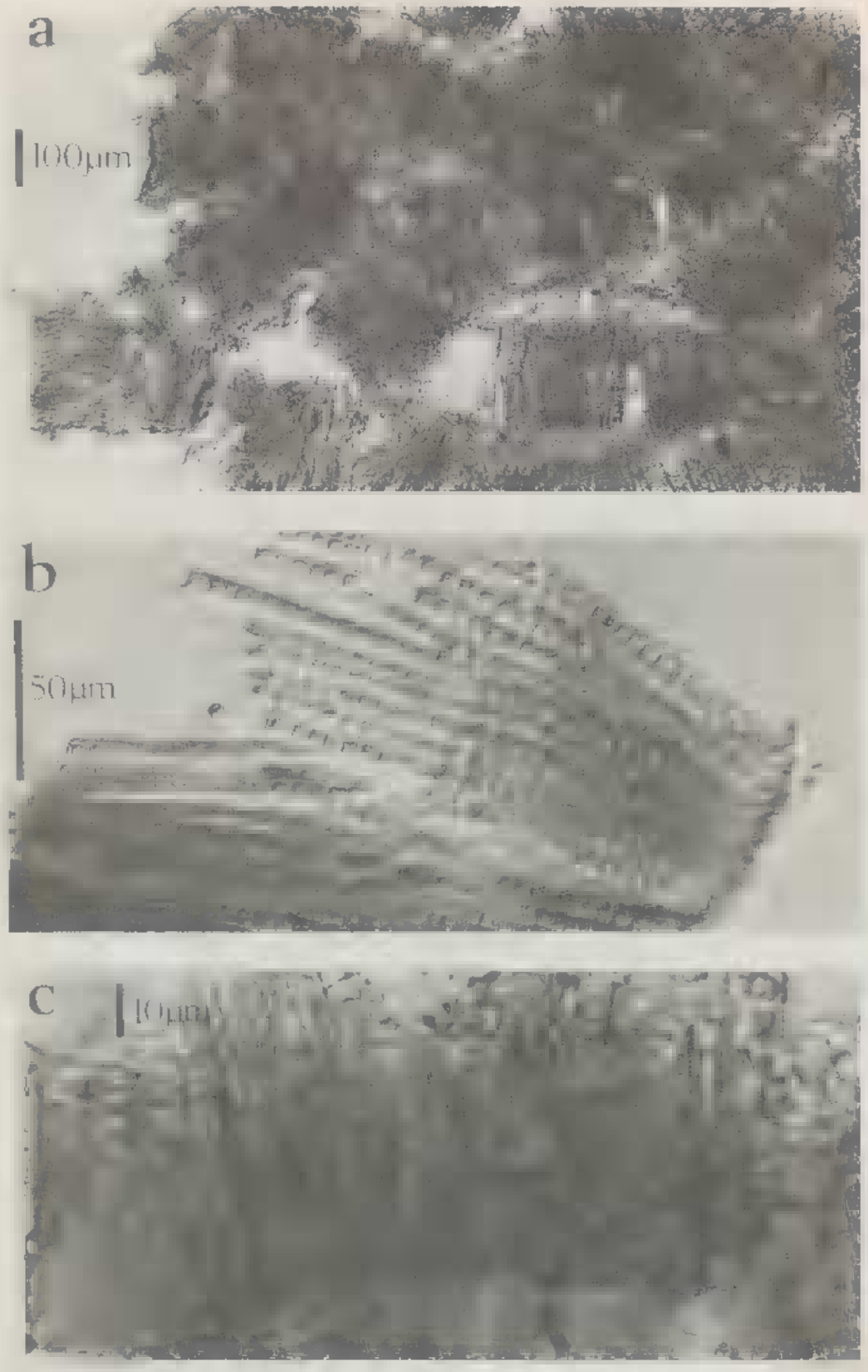

Fig. 2 - Vertical section of *Stauromatonema viride* leg. Carmona-Jiménez. a) Thallus. b) Compact pseudoparenchyma with probable reproductive structure. c) Basal portion, globose cells (arrow).

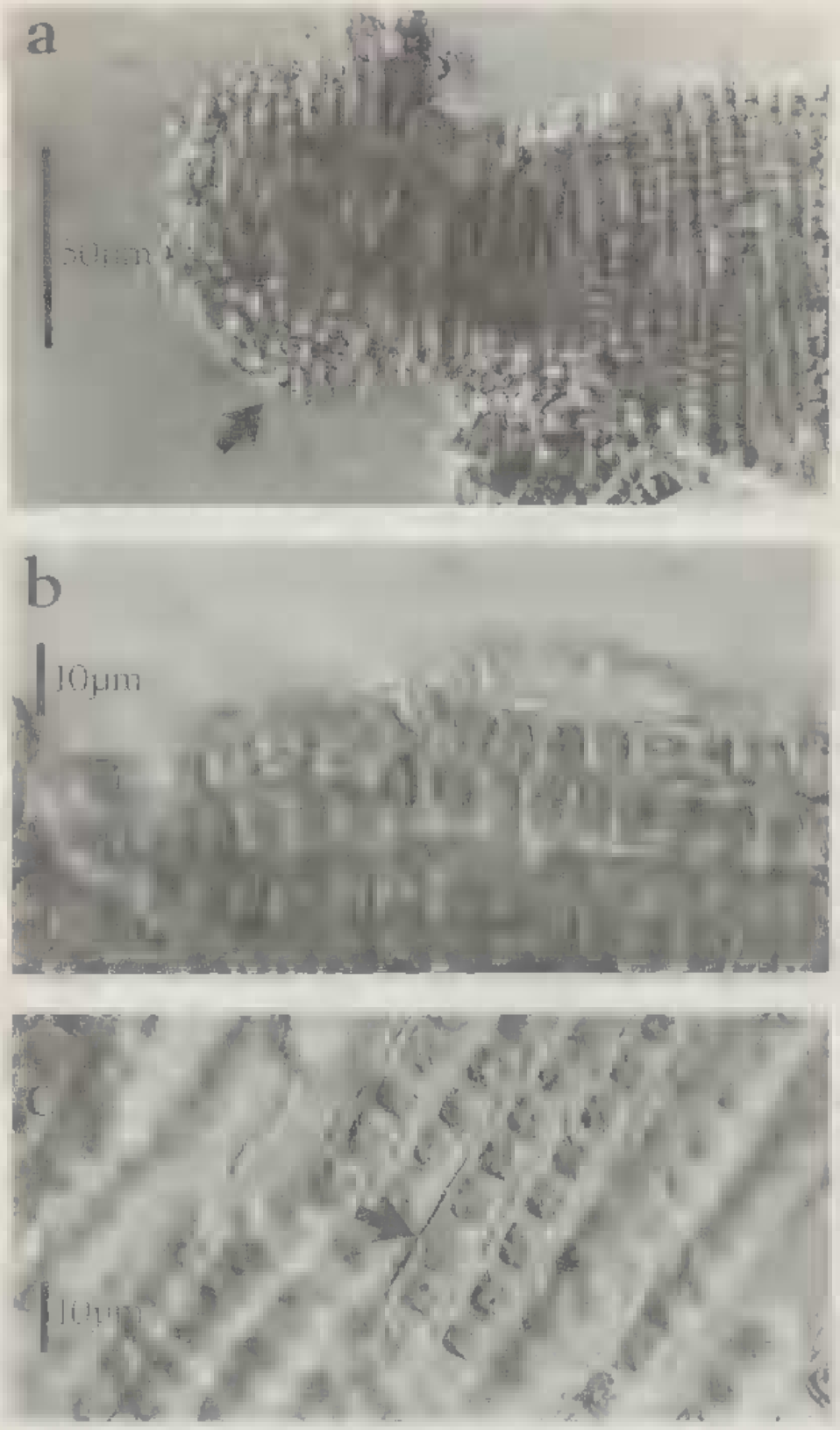

Fig. 3 - Vertical section of *Stauromatonema viride* leg. Carmona-Jiménez. a) Basal portion pseudoparenchymatous, honeycomb-like (arrow). b) True branching. c) Quadrate heterocysts (arrows); granular cell content.

Tab. I - Comparison at the generic level between previous reports of *Stauromatonema* and the Mexican material.

Feature	Frémy, 1930	Geitler & Rurmer, 1935/1936	Govindu & Safeeulla, 1950	Carmona-Jiménez & Gold-Morgan, 1994
habit	gelatinous macroscopic	macroscopic	macroscopic	microscopic
growth form	crust	crust	crust	crust
erect portion	pseudoparenchyma of uniseriate filaments, slightly separated from each other	uniseriate filaments, narrowing towards the base	concrescent cushion of parallel filaments	pseudoparenchyma of uniseriate filaments
basal portion adult	prostrate base	?	cellular layer of twisted filaments	prostrate basal portion lacking; occasionally pseudo-parenchyma of globose cells
juvenile	?	prostrate filaments irregularly twisted	?	?
branching	regular dichotomic	sparse, lateral or pseudodichotomic	pseudodichotomic curved upwards and parallel	sparse, lateral parallel to the principal filament
sheath	slightly lamellated, septate, hyaline	not very visible	firm	not very visible
heterocysts	intercalary	absent or intercalary	few and refractive	sparse, intercalary refractive
reproductive structures	planococci and gonidia chroococcoïde	gonidia planococci	planococci	planococci

? = Not reported

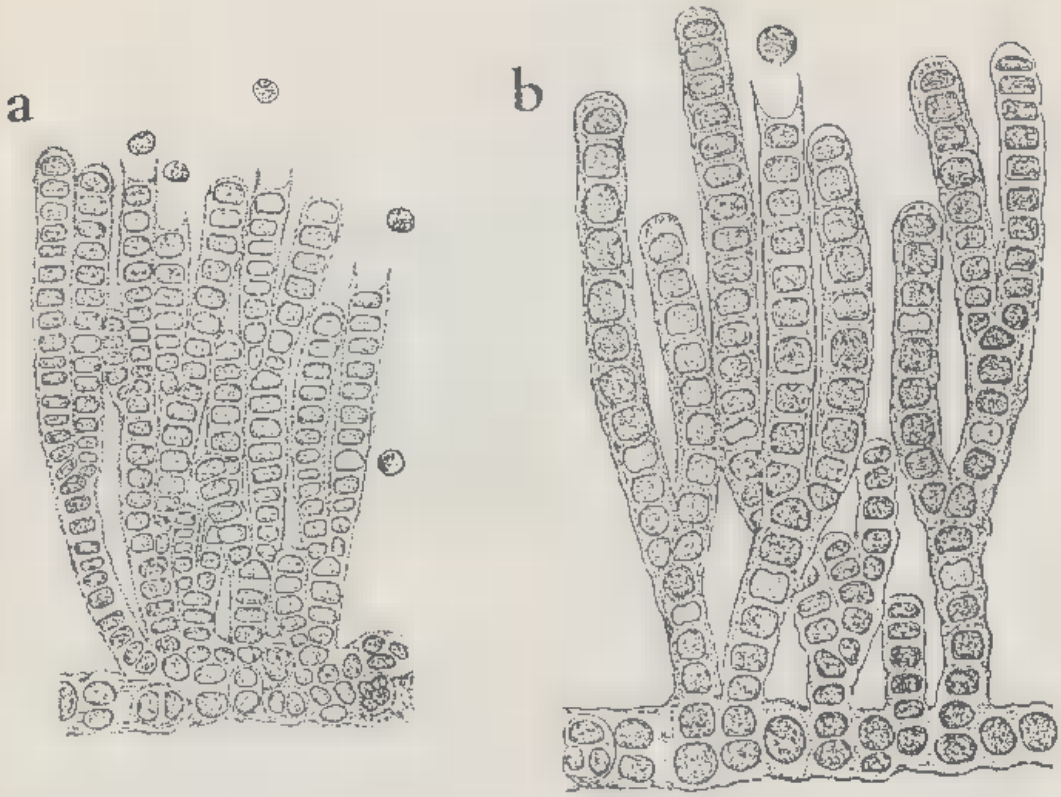

Fig. 4 - Vertical section of a) *Stauromatonema nigrum* leg. Le Testu. b) *S. viride* leg. Le Testu. (Reduced from Frémy 1930).

portion, although their drawing shows a layer of globose cells with all cell walls touching the neighbouring ones; no twisted filaments are apparent (Fig. 5a).

In our material we found only adult stages (no young stages) and the two types of basal strata described above: a row of globose cells which are larger than the vegetative cells, from which the erect filaments grow (Fig. 2c and 6a), and the honeycomb-like basal portion (Fig. 3a and 6b). There is no doubt that there are no creeping filaments in the first type of basal stratum because the material was not damaged when separated from the substrate, which was compact mud, and the row of globose cells was very clear (Fig. 2c). In the second type nothing resembling a filament was observed. The erect filaments from both types of basal portion are indistinguishable from each other.

In all drawings of *Stauromatonema* the habit of the erect part is very similar, except in the compactness of the filaments. In Frémy (1929), although the description mentions that filaments and branches are «soudés», in the drawing they are often separated from each other (Fig. 4 a, b). In the drawings of Geitler (1942) and in our material the structure of the thalli is as Geitler says, very similar to *Hildenbrandia* (Fig. 2b and 5b).

We occasionally observed spherical or subquadrate structures which seemed to be liberated from apical cells. They are very similar to those drawn by Frémy (1929)

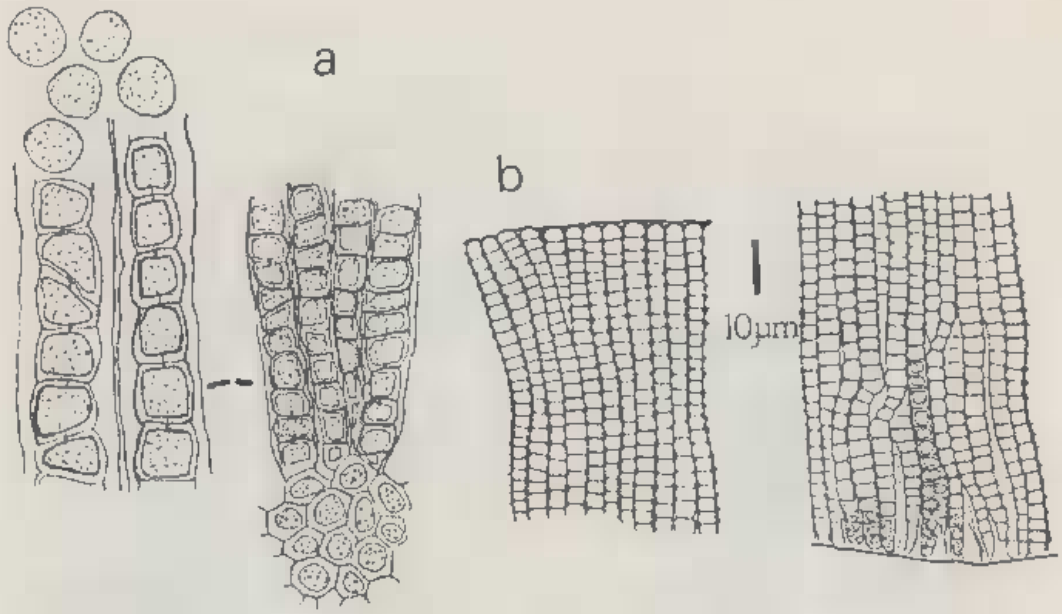

Fig. 5 - Vertical section of a) *S. viride* leg. Govindu et Safeeulla (from Govindu & Safeeulla 1950). b) *Stauromatonema minutissimum* collector unknown (from Geitler & Ruttner 1935/1936).

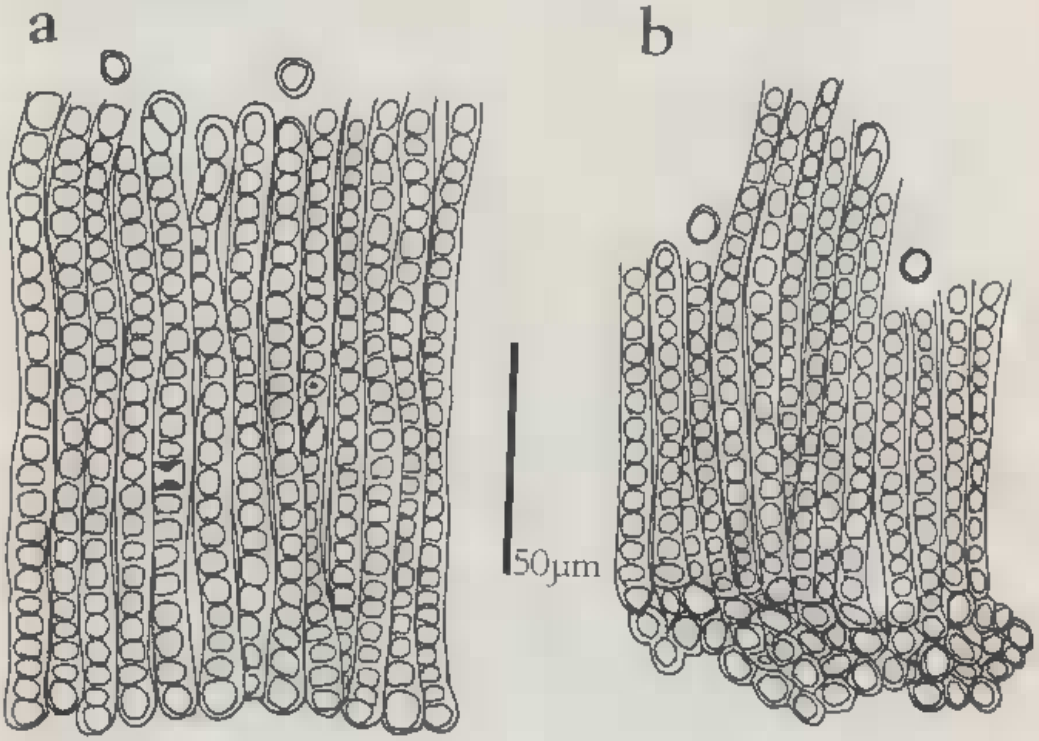

Fig. 6 - Vertical of *Stauromatonema viride* leg. Carmona-Jiménez. a) Compact pseudoparenchyma. b) Honeycomb-like basal portion.

Table II - Comparison at the specific level between previous reports of *Stauromatonema* and the Mexican material.

Feature	*Stauromatonema nigrum* Frémy, 1930, Gabon	*Stauromatonema viride* Frémy, 1930, Gabon. Geitler & Ruttner, 1935/1936, Java	*Stauromatonema viride* Govindu & Safeeulla, 1950, Mysore	*Stauromatonema minutissimum* Geitler & Ruttner, 1935/1936, Java	*Stauromatonema viride* Carmona-Jiménez & Gold-Morgan, 1994, Veracruz
color of thallus	black	green	brownish-green	dark-green	dark-green
width of filament (µm)	6.5-8	10-12	5-9, mean=7	3-4	5.5-11.2
width of protoplast (µm)	3.5-5	6-8.5	?	(2)2.5-3	4.4-10.0
width and shape planococci (µm)	3.5-5 disk-shaped	6-8 disk-shaped	similar to Frémy's	?	5.3-8.2 disk-shaped
habitat	river, on siliceous rock	river, on schists	submerged rocks and small pebbles, exposed directly to water currents	river	pool on emerging basaltic rock facing a waterfall; epipelic

? = Not reported

and Govindu & Safeeula (1950). According to Frémy, they could be planococci and according to Govindu & Safeeulla (1950), gonidia. Our material was only observed fixed, therefore we do not know whether they were motile or not.

At the specific level, our material corresponds closely to *Stauromatonema viride* except that the width of the filament overlaps with the values of *Stauromatonema viride* and of *Stauromatonema nigrum* (see Tab. II). In fact, Geitler & Ruttner (1935/1936) comment that the delimitation between the two species in the material from Sumatra was not easy because there were intermediate forms; they decided to include such forms in *Stauromatonema viride*. *Stauromatonema nigrum* is probably within the range of variation of *Stauromatonema viride* and therefore a synonym.

One difference between the Mexican material and that reported in the literature is the habit in the field. All other authors have reported their material from rivers, whereas our material was found in a pool, although not stagnant. Additionally, *Stauromatonema* from Africa, Sumatra and India is reported as a conspicuous epilithic crusts; our material was neither abundant, conspicuous nor epilithic.

To date this genus has been found exclusively in tropical regions, which perhaps explains why it has been so infrequently reported. The fact that it has such a wide geographic distribution supports the idea that it is a good genus, but its taxonomy at the species level is still unclear. More material is needed as well as more detailed reports on its environmental conditions to be able to assess ranges of morphological variation and ecological requirements.

ACKNOWLEDGEMENTS

We are grateful to Dr. Jiri Komárek for bringing this little-known genus to our attention and for his valuable comments and Prof. Gustavo Montejano for revision of the manuscript and helpful suggestions.

REFERENCES

ANAGNOSTIDIS K. & KOMAREK J., 1990 - Modern approach to the classification system of Cyanophytes. 1. Stigonematales. *Arch. Hydrobiol./Suppl. 86. Algological Studies* 59: 1-73.

BOURRELLY P., 1970 - *Les Algues d'eau douce. Initiation à la systématique. III.* N Boubée et Cie. Paris. 512 p.

FRÉMY P., 1930 - Les Myxophycées de l'Afrique équatoriale française. *Arch. Bot.* 3(2): 508 p.

GEITLER L., 1942 - *Schizophyta* (Klasse Schizophyceae). Duncker and Humblot. Berlin, 232 p.

GEITLER L. & RUTTNER F., 1935/1936 - Die Cyanophyceen der deutschen limnologischen Sunda-Expedition; ihre Morphologie, Systematik und Ökologie. *Arch. Hydrobiol./Suppl. 14. «Tropische Binnengew.»* 6: 308-715.

GOVINDU H.C. & SAFEEULLA K.M., 1950 - A species of *Stauromatonema* in Mysore. *Nature* 165: 80.